

Programmable Interpolation Unit

IPE1000-U

User Manual



Revision History

Date	Revision	Changing
16.12.2003	1.0	First version
22.06.2004	1.1	Input connector pinning
02.07.2004	1.2	Output signal description, Soldering Jumper J10
11.03.2005	1.3	Several changings
25.05.2005	1.4	Dimensions added

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2 Overview

The programmable interpolation unit IPE1000-U has been designed for connection to incremental position and angle measuring systems with sine-shaped output signals with a 90° phase shift. It can be operated at a large number of transducer systems working according to the most varied measuring principles. With a maximum interpolation rate of 1000 the IPE1000-U is capable to split the input signal period into up to 1000 segments. An RS422 interface for square wave outputs is available.

Proprietary automatic gain and offset control, as well as the possibility of a analogue phase correction of the internal GC-IP1000 ensure a high measuring precision under industrial conditions.

Block diagram

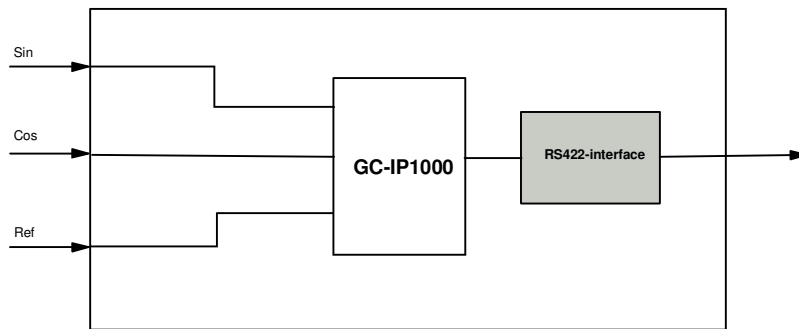


Fig. 1 Block diagram

3 Input Signals

The input signals of the IPE1000-U are analogue voltages (sine/cosine), which have a sine-shaped dependency on the measured value (position or angle). The phase shift between those two analogue voltages is 90°, related to one period of the scale. A third input signal serves the zero or reference point of the scale as a reference signal for determining. All the three input signals are processed as differential or single ended signals. Another version of the device with current inputs is also available (IPE1000-I).

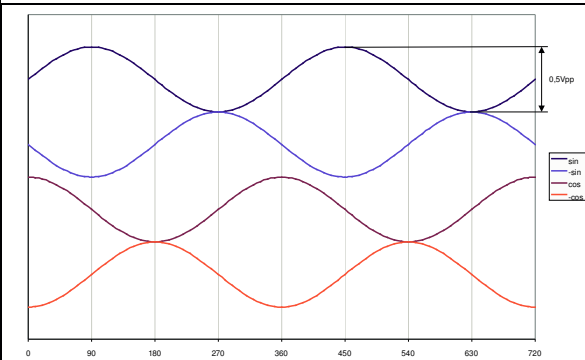


Fig. 2 Input signals differential

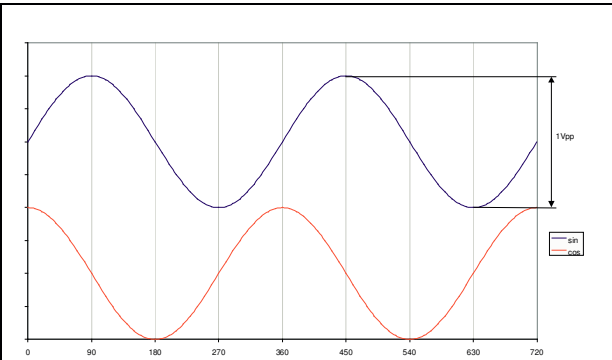


Fig. 3 Input signals single-ended

3.1 Connection of a Measuring System

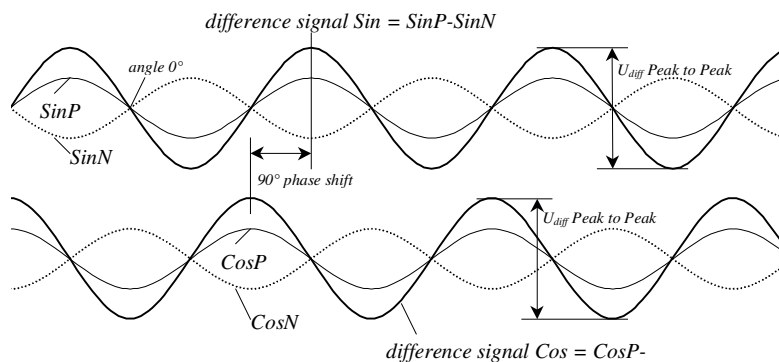


Fig. 4

G1	G0	Gain (nominal)	Input voltage for differential input ¹⁾	Input voltage U_{Diff} (nominal)	Input voltage range for U_{Diff}	maximum signal offset
open	closed	19.5	50mV _{pp}	100mV _{pp}	80 mV _{pp} ... 120 mV _{pp}	±10mV
open	open	16.25	60mV _{pp}	120mV _{pp}	96 mV _{pp} ... 144 mV _{pp}	±12mV
closed	closed	13.45	72mV _{pp}	145mV _{pp}	145 mV _{pp} ... 174 mV _{pp}	±14.5mV
closed	open	1.95 ²⁾	0.5V_{pp}	1V_{pp}	0.8V_{pp} ... 1.2V_{pp}	±100mV

¹⁾ at each of the inputs $SINP$, $SINN$, $COSP$, $COSN$

²⁾ Default value

See also chapter 8.1

3.2 Signal Correction

The input signals are subject to the internal automatic gain and offset control of the IP1000, which is patented by GEMAC. The amplitude controller is specified for a control range of $\pm 20\%$ of nominal input voltage. The offset of the external signals must not exceed a value of $\pm 10\%$ of nominal input voltage. The phase shift of the input signals can be adjusted statically by the internal potentiometer in a range of $\pm 6^\circ$ or $\pm 12^\circ$ via SPI. There are two measuring points (MP1 and MP2) for testing the signals. The signal at each of those measuring points should have an amplitude of $2.0V_{pp}$ and an offset of $2.275V$ referring to Ground.

For achieving the best interpolation performance, the gain-offset-controller needs approximately 20 signal periods for reaching a steady state. Until this time, the input signal frequency must not exceed 50% of the specified maximum signal frequency (please refer to chapter 5.1).



For reaching the highest accuracy of the gain-offset regulation the phase should adjust. This will be very important if high interpolation rates are used.

3.3 Reference Signal

A third output of the measuring system - typically called reference, index point or zero point signal – will be considered to be activated, if the difference of the signals at the REFP and REFN pins becomes bigger than the positive hysteresis voltage V_{RPH} and will be considered to be deactivated if this voltage becomes smaller than the negative hysteresis voltage V_{RPL} .

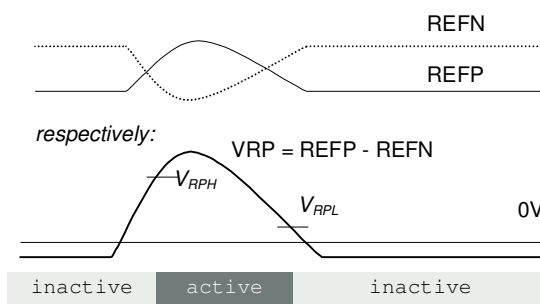


Fig. 5

$U_{RPL} \text{ (typ.)} = -30mV$
 $U_{RPH} \text{ (typ.)} = +30mV$



If a sensor without reference signals is used, defined levels on pins REFP and REFN are necessary to set the index point always active or always inactive.

Reference signal at the output active in each period	Reference signal at the output inactive
LJ 19: b-c	LJ 19: a-b
LJ18: open	LJ18: open
R11: placed	R11: placed

4 Output Signals

4.1 Output Signals RS422

The output signals are phase shifted square wave sequences (known by incremental measuring transducers). They can be counted in a single or quadruple way. A synchronous reference pulse will be generated when the angle of 0° (refer also to Fig. 3) is passed through and when the analogue differential input voltage between $REFP$ and $REFN$ exceeds the positive comparator hysteresis level. If the differential input voltage is permanently above this level, the reference pulse will be generated once during every signal period.

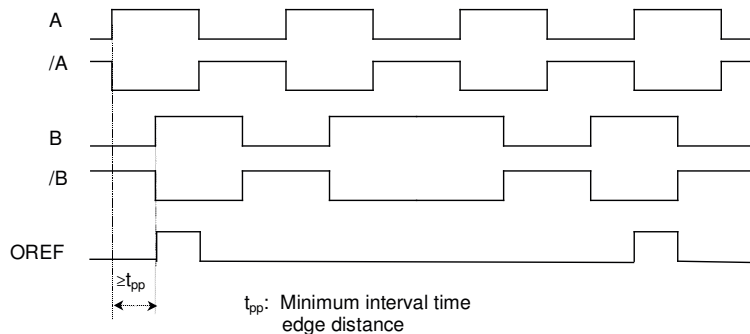


Fig. 6 Output signals

For generating a reference pulse at the output and the exact assignment of the signals A, B and OREF it is necessary to pass a Sin/Cos-period (for finding the zero degree angle). That status will be signaled by a green Valid-LED (LED 3, looked status). In the case of an error the red Error-LED (LED 2) is switched on and the green Valid-LED is switched off. An external reset pulse with a minimum length of $3\mu s$ will restart the GC-IP1000. To get the locked status again a further Sin/Cos-period is needed.



In case of selected interpolation rates 125 and 250-fold the assignment of A, B and OREF can not be guaranteed.

4.2 Error Signal

An error signal will be generated if the input signals are plausible no longer. The error signal will also be generated if the input frequency is so high that the square-wave signals are unable to follow, and/or when the maximum input frequency is exceeded.



If the error signal was activated, and/or if one of the error bits was set in the result register, the present measuring result and all the following results would have to be discarded. Following elimination of the cause of the error and a reset of the error bit, the reference point has to be passed by for absolute value measurements once again!

5 Interpolation Rate

The interpolation rate can be set at 1000, 800, 500, 400, 250, 200, 125 and 100. The interpolation rate as defined for the purposes of this application is the number of increments into which one sine period of the input signal is divided. This also corresponds to the number of edge changes on the A/B output signals per input signal period. This means that the number of square-wave periods at the A and B outputs totals $1/4$ of the interpolation rate per input signal period.



In the case that a standard interpolation counter or quadrature decoder is connected to the A/B outputs, this has to work in "quadruple evaluation" mode in order to achieve the full interpolation rate.

5.1 Interval Time / Maximum Input Frequency

The interval time (IT) respectively the minimum edge distance (t_{pp}) at the output signals can be adjusted using the same DIL-Switch as for the interpolation rate. This is possible from $1/f_{osc}$ to $128/f_{osc}$ in binary steps. The following table shows the maximum input frequencies under consideration of the interval times.

Clock frequency example

$f_{OSZ} = 22\text{MHz}$				$f_{maxCNT} = 110\text{kHz}$			
IR	IT	t_{pp}	f_{max}	IR	IT	t_{pp}	f_{max}
1000	1	45ns	19k	800	1	45ns	25k
	2	91ns	10k		2	91ns	12.5k
	4	181ns	5k		4	181ns	6.2k
	8	363ns	2.5k		8	363ns	3.1k
	16	727ns	1.2k		16	727ns	1.5k
	32	1.4µs	600		32	1.4µs	775
	64	2.9µs	300		64	2.9µs	380
	128	5.8µs	150		128	5.8µs	190
250	1	45ns	80k	200	1	45ns	100k
	2	91ns	40k		2	91ns	50k
	4	181ns	20k		4	181ns	25k
	8	363ns	10k		8	363ns	12.5k
	16	727ns	5k		16	727ns	6.2k
	32	1.4µs	2.5k		32	1.4µs	3.1k
	64	2.9µs	1.2k		64	2.9µs	1.5k
	128	5.8µs	600		128	5.8µs	775
100	1	45ns	40k	125	1	45ns	110k
	2	91ns	20k		2	91ns	80k
	4	181ns	10k		4	181ns	40k
	8	363ns	5k		8	363ns	20k
	16	727ns	2.5k		16	727ns	10k
	32	1.4µs	1.2k		32	1.4µs	5k
	64	2.9µs	600		64	2.9µs	2.5k
	128	5.8µs	300		128	5.8µs	1.2k
400	1	45ns	50k	100	1	45ns	110k
	2	91ns	25k		2	91ns	100k
	4	181ns	12.5k		4	181ns	50k
	8	363ns	6.2k		8	363ns	25k
	16	727ns	3.1k		16	727ns	12.5k
	32	1.4µs	1.5k		32	1.4µs	6.2k
	64	2.9µs	775		64	2.9µs	3.1k
	128	5.8µs	380		128	5.8µs	1.5k



These values apply on condition of an adjusted phase between the input signals and a steady state of the internal gain-offset-controller. Until this time, the input frequency must not exceed 50% of the specified maximum frequency.

5.2 Glitch Filter

In order to avoid permanent toggling of the downstream counters as a result of analogue noise of the input signals while the measuring system is in standstill, a digital filter can be optionally activated for the square-wave outputs (pin / bit GFE). In such a case, the minimum edge distance at the output (t_{pp}) is then automatically set at $1024/f_{osc}$ while the measuring system is in standstill or at smaller input frequencies.



Note that in the switching range to the automatic activation / deactivation of this filter, the A/B output signals are not speed-proportional in each case!

LJ10 - jumper for glitch filter	description
open	glitch filter active
closed	glitch filter inactive

For finding the jumper position please refer to chapter 8.

6 Specifications

Recommended Operating Conditions	MIN	NOM	MAX	Unit
Supply voltages	4.75	5.0	5.25	V
Supply current		130		mA
Operating case temperature	-20		85	°C
Analogue Input Specifications	MIN	NOM	MAX	Unit
Input frequency range SIINP,SINN,COSP,COSN			400	kHz
Phase offset between SIN and COS		90		°
Peak to peak input voltage SINN \Leftrightarrow SINEP / COSN \Leftrightarrow COSP	0.8	1.0	1.2	V _{pp}
Phase deviation	±8	±10	±12	°
Oscillator frequency		20		MHz
Reset Specifications	MIN	NOM	MAX	Unit
Reset impulse length	3			µs
Interpolation	MIN	NOM	MAX	Unit
Input frequency range	0		f _{osz} / 96	kHz
Automatic gain control range		±20%		related to nom. amplitude
Automatic offset control range		±10%		
Interpolation Rates	20 / 25 / 40 / 50 / 80 / 100 / 160 / 200			
Minimum interval time A/B - Signals	1 / f _{osz}		128 / f _{osz}	ns
Interpolation accuracy		±0.6	±1	Inc.
Propagation delay counter		90 / f _{osz}		ns
Propagation delay square-wave outputs (A/B/OREF)		122 / f _{osz}		ns
Other characteristics	Extruded aluminium housing		die-cast box housing	
Degree of protection (depends on the housing)	IP20		IP65	
Connector	Sub-D 15 pin		Round plug 9- and 12pin	
Dimensions	55mm x 80mm x 20mm		100mm x 66mm x 50mm	

7 Configuration of the Switches and Connectors

It is necessary to open the unit for configuration. This can be done by open the screws at both sides. The cover can be lift off now.

7.1 Extruded Aluminium Housing IP20

Signal input - Sub-D 15-pin female

Pin No.	Signal
1	SINP
2	0VDC
3	COSP
4	+5VDC
5	
6	
7	REFN
8	
9	SINN
10	0VDC
11	COSN
12	+5VDC
13	
14	REFP
15	

Signal output - Sub-D 15-pin male

Pin No.	Signal
1	AP
2	0VDC
3	BP
4	+5VDC
5	EP
6	
7	RN
8	NERR
9	AN
10	0VDC
11	BN
12	+5VDC
13	ext. trigger
14	RP
15	EN

7.2 Die-Cast Box Housing IP65

Round plug 9-pin (Signal input)

Pin No.	Signal
1	SINN
2	SINP
3	+5VDC
4	0VDC
5	COSN
6	COSP
7	REFN
8	REFP
9	PE

Round plug 12-pin (Signal output)

Pin No.	Signal
1	AN
2	AP
3	BN
4	BP
5	RN
6	RP
7	EN
8	EP
9	+5VDC
10	0VDC
11	external Trigger
12	n.c.

7.3 DIL-Switch

Switch No.	Signal Name		On	Off
1	IR0	Interpolation rate	See table Interpolation rate	
2	IR1			
3	IR2			
4	IT0	Minimum edge distance at the outputs	See table edge distance	
5	IT1			
6	IT2			

7.4 Interpolation Rate

IR2	IR1	IR0	Interpolation rate
OFF	ON	ON	1000
ON	ON	ON	800
OFF	ON	OFF	500
ON	ON	OFF	400
OFF	OFF	ON	250
ON	OFF	ON	200
OFF	OFF	OFF	125
ON	OFF	OFF	100

7.5 Minimum Edge Distance at the Outputs

IT2	IT1	IT0	Interval time $1/f_{osz}$
ON	ON	ON	1
ON	ON	OFF	2
ON	OFF	ON	4
ON	OFF	OFF	8
OFF	ON	ON	16
OFF	ON	OFF	32
OFF	OFF	ON	64
OFF	OFF	OFF	128

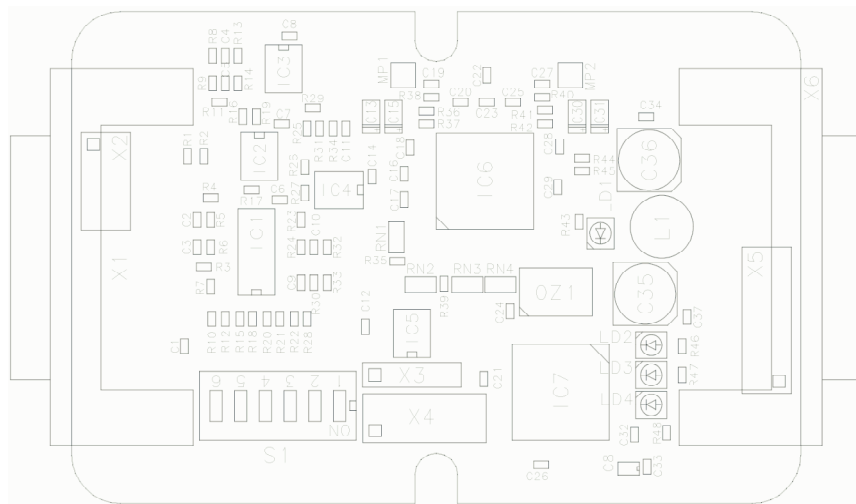
7.6 Service Connector SPI

Pin No.	Signal
1	SDO
2	SDI
3	SCLK
4	SCEN
5	NERR
6	NRES
7	0VDC
8	0VDC
9	+5VDC
10	+5VDC

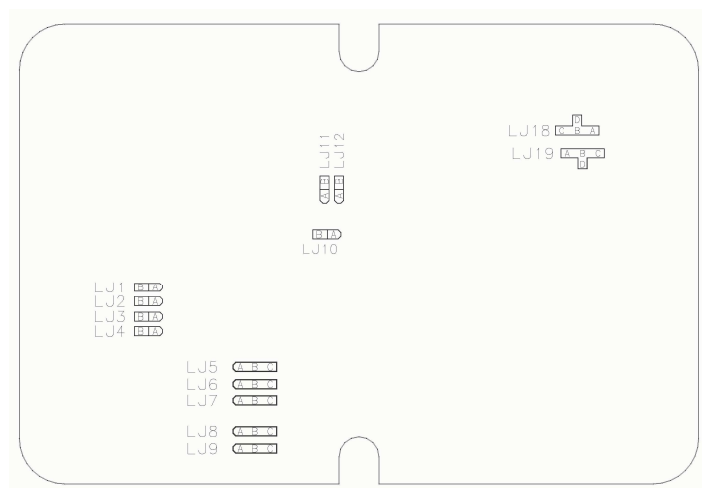
7.7 LED

LED 1	Power supply
LED 2	Error LED see chapter4
LED 3	Valid LED see chapter4
LED 4	Reset

8 Component Mounting Diagram



8.1 Soldering Jumper Solder Side

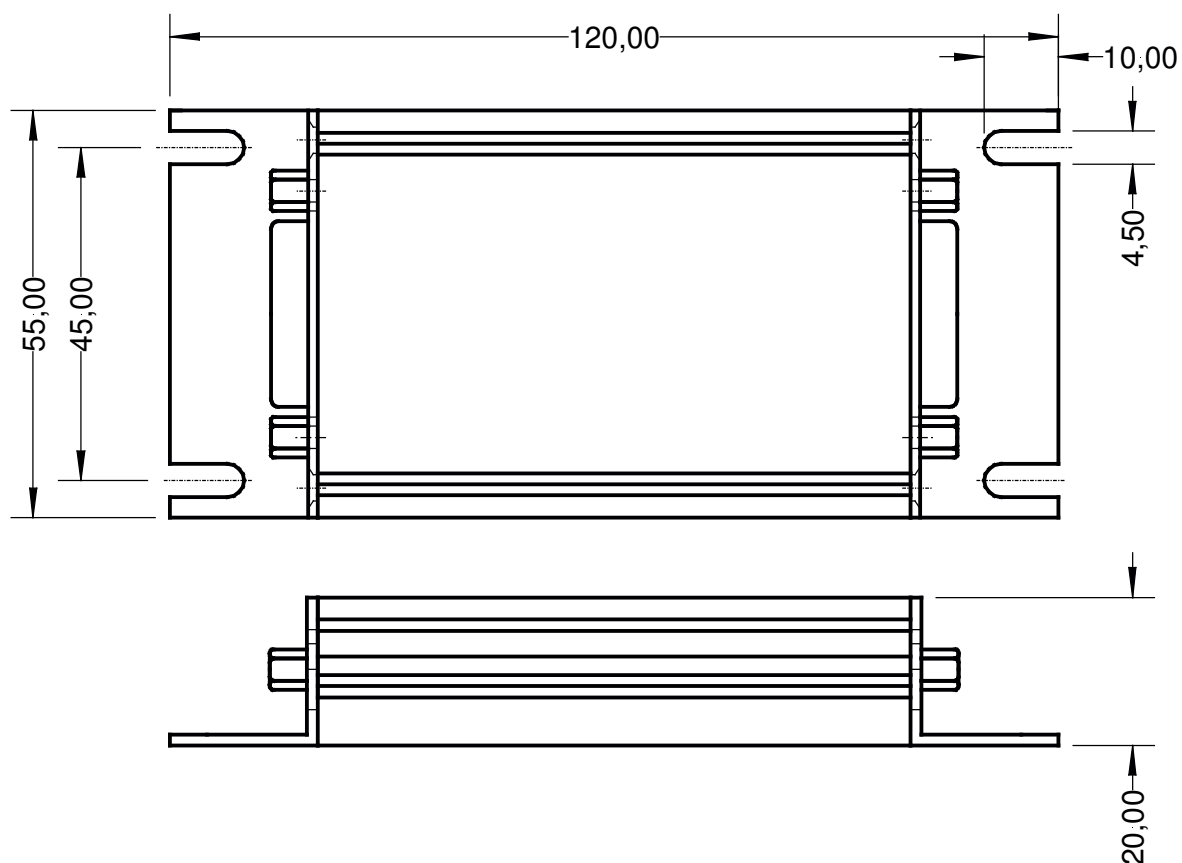


Jumper for gain adjustment	Signal
LJ11	G0
LJ12	G1

G0	G1	Gain
close	open	19,5
open	open	16,2
close	close	13,4
open	close	1,95 (default)

Jumper LJ10 for glitch filter activation	Description
Open	glitch filter active
closed	glitch filter inactive

8.2 Dimensions



All dimensions in mm.